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Concurrency Theory WS 2017/2018

— Series 4 —

Hand in until November 10 before the exercise class.

Exercise 1 (Dining Philosophers) (1+2+2+1 Points)

The philosophical society employs two philosophers, Phil_1 and Phil_2. Both spend their time either thinking or eating at a table with a large spaghetti bowl, one Spoon and one Fork. Each philosopher usually keeps thinking, but at any point in time, he may decide to eat. When philosopher Phil_1 decides to eat, he picks up the fork, then picks up the spoon, then eats, then releases the fork and then releases the spoon. When philosopher Phil_2 decides to eat, he picks up the spoon, then picks up the fork, then eats, then releases the spoon and then releases the fork.

(a) Complete the following CCS process definition such that it describes the operation of the philosophical society! Use the set of actions names $\text{A} = \{\text{eat}_1, \text{eat}_2, \text{pickUpFork}, \text{releaseFork}, \text{pickUpSpoon}, \text{releaseSpoon}\}$!

$$\begin{aligned}
\text{Society} &= (\text{Phil}_1 \parallel \text{Phil}_2 \parallel \text{Spoon} \parallel \text{Fork}) \\
&\qquad \setminus \{\text{pickUpFork}, \text{releaseFork}, \text{pickUpSpoon}, \text{releaseSpoon}\} \\
\text{Phil}_1 &= ? \\
\text{Phil}_2 &= ? \\
\text{Spoon} &= ? \\
\text{Fork} &= ?
\end{aligned}$$

(b) Draw the corresponding LTS and argue by observation of the LTS that the system exhibits a deadlock! You may use abstract names for the states.

(c) Give an HML formula with one variable D which expresses the absence of a deadlock in any arbitrary LTS and argue by applying fixed–point iteration to the semantics of D with respect to the LTS from (c) that the system exhibits a deadlock!

(d) What strong recommendation should the philosophical society give to the philosophers regarding their eating behavior such that the system no longer exhibits a deadlock? Justify your answer!

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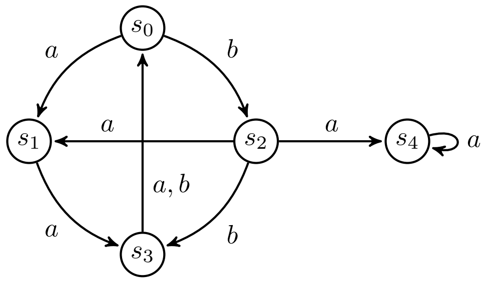
Exercise 2 (Mutually Recursive Equation Systems) (2 Points)

Consider the LTS



and the mutually recursive equation system

$$E = \begin{pmatrix} X_1 & \overset{\min}{=} & [a]X_1 \vee \langle b\rangle X_2 \\ X_2 & \overset{\max}{=} & [b]X_2 \wedge \langle b\rangle X_2 \end{pmatrix}.$$

Do the fixed–point iteration for $[\![E]\!]$!

Exercise 3 (HML with One Variable) (2 Points)

Prove that there exists no HML formula with one variable F such that for every LTS $(S, Act, \rightarrow)$ with $|S| \geq 2$ neither S nor $\emptyset$ are a fixed–point of $[\![F]\!]$!